Stoller
Hanford Office

DOE-EM/GJ672-2004

299-W22-14 (A7839)
Log Data Report

Borehole Information:

Borehole: 299-W22-14 (A7839)			**Site:** 216-S-7 Crib		
Coordinates (WA State Plane)		**GWL (ft)[1]:** 235.95		**GWL Date:** 04/29/2004	
North	**East**	**Drill Date**	**TOC[2] Elevation**	**Total Depth (ft)**	**Type**
134,166.146 m	567,186.931 m	March 1956	207.799 m	342	Cable Tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Welded steel	+2.3	8 5/8	8	5/16	+2.3	342
Welded steel	+0.5	4 1/2	4	1/4	0.5	206.3
The logging engineer used a caliper to determine the outside 8-in. casing diameter. The caliper and casing stickup were both measured using a steel tape. Inside casing diameter was measured with a steel tape. All measurements were rounded to the nearest 1/16 in. Casing bottom is as reported from the well completion summary report (Ledgerwood 1993).						

Borehole Notes:

Borehole coordinates, elevation, and well construction information, as shown in the above tables, are from measurements by Stoller field personnel, Ledgerwood (1993), and HWIS[3]. Zero reference is the top of the 8-in. casing.

Logging Equipment Information:

Logging System: Gamma 1G		**Type:** SGLS (35%) 34TP40587A
Calibration Date: 01/2004	**Calibration Reference:**	GJO-2004-597-TAC
	Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4 / Repeat	
Date	04/28/04	04/29/04	05/03/04	05/03/04	
Logging Engineer	Spatz	Spatz	Spatz	Spatz	
Start Depth (ft)	71.0	235.0	135.0	70.0	
Finish Depth (ft)	3.0	134.0	71.0	46.0	
Count Time (sec)	200	200	200	200	
Live/Real	R	R	R	R	
Shield (Y/N)	N/A[4]	N/A	N/A	N/A	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
ft/min	N/A	N/A	N/A	N/A	

Log Run	1	2	3	4 / Repeat	
Pre-Verification	AG076CAB	AG077CAB	AG078CAB	AG078CAB	
Start File	AG076000	AG077000	AG078000	AG078065	
Finish File	AG076068	AG077101	AG078064	AG078089	
Post-Verification	AG076CAA	AG077CAA	AG078CAA	AG078CAA	
Depth Return Error (in.)	-1	-1	N/A	0	
Comments	No fine-gain adjustment.	Fine-gain adjustment after files -005, -014, and -025.	No fine-gain adjustment.	Repeat section.	

Logging Operation Notes:

Zero reference was top of the 8-in. casing. Logging was performed without a centralizer installed on the sonde. Pre- and post-survey verification measurements for the SGLS employed the Amersham KUT (^{40}K, ^{238}U, and ^{232}Th) verifier with serial number 118.

Analysis Notes:

Analyst:	Sobczyk	Date:	5/06/04	Reference:	GJO-HGLP 1.6.3, Rev. 0

SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day. All of the verification spectra were within the acceptance criteria. The peak counts per second (cps) at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectra as compared to the pre-run verification spectra for each day were between 1.9 percent lower and 6.3 percent higher at the end of the day. Examinations of spectra indicate that the detector appears to have functioned normally during logging, and the spectra are accepted.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source file: G1GJan04.xls). Zero reference was the top of the 8-in. casing. On the basis of Ledgerwood (1993) and the field measurements, the casing configuration was assumed to be a string of 4-in. casing with a thickness of 1/4 in. to a log depth of 206.3 ft and a string of 8-in. casing with a thickness of 5/16 in. to total logging depth (235 ft). Where more than one casing exists at a depth, the casing correction is additive (e.g., the correction for both 4-in. and 8-in. casing would be 0.25 + 0.313 = 0.563). Dead time and water corrections were not required.

Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, naturally occurring radionuclides (^{40}K, ^{238}U, and ^{232}Th), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations on the combination plot rather than the ^{214}Bi peak at 609 keV because it is less affected by the presence of radon in the borehole.

Results and Interpretations:

^{137}Cs, ^{238}U, and ^{60}Co were the man-made radionuclides detected in this borehole. ^{137}Cs was detected near the ground surface (3 and 4 ft) at concentrations between 0.4 and 0.6 pCi/g. ^{137}Cs was detected in the interval between 25 and 60 ft at concentrations ranging from the MDL (0.3 pCi/g) to 450 pCi/g. The maximum concentration of ^{137}Cs was measured at 35-ft log depth. ^{137}Cs was detected in the intervals between 70 to 84 ft and 132 to 134 ft at concentrations ranging from 0.3 to 0.7 pCi/g. In addition, ^{137}Cs was detected at 91 and 207 ft at concentrations near the MDL. Processed ^{238}U, based on the 1001-keV photopeak, was detected at 46 and 47 ft at concentrations of 24 and 31 pCi/g, respectively. ^{60}Co, based on the 1333-keV photopeak, was detected at 46, 138, 210, 212, and 221 ft at concentrations near the MDL (0.1 pCi/g).

The KUT logs showed significant changes despite the presence of grout, which masks the KUT response to a depth of 204 ft. Apparent ^{40}K concentrations increase by approximately 5 pCi/g at 57 ft, and this increase may correspond with transition from the gravel-dominated facies of the Hanford H1 to the sand-dominated facies of the Hanford H2. Apparent ^{232}Th concentrations are elevated by approximately 0.4 pCi/g in the interval between 146 and 156 ft, and this increase corresponds with fine-grained sediment of the Cold Creek Interval formerly known as the Early Palouse Soil. The relatively low ^{40}K and ^{232}Th values in the interval between 157 and 167 as well as the relatively high ^{238}U values near 159 ft are characteristic of the carbonate palesols of the Cold Creek Interval. The top of the Ringold is picked at 168 ft.

The behavior of the ^{238}U log suggests that radon may be present inside the borehole casing. Determination of ^{238}U is based on measurement of gamma activity at 609 and/or 1764 keV associated with ^{214}Bi, under the assumption of secular equilibrium in the decay chain. However, ^{214}Bi is also a short-term daughter of ^{222}Rn. When radon is present, ^{214}Bi will tend to "plate" onto the casing wall and will quickly reach equilibrium with ^{222}Rn. Because the additional ^{214}Bi resulting from radon is on the inside of the casing, the effect of the casing correction is to amplify the 609 photopeak relative to the 1764 photopeak. (The magnitude of the casing correction factor decreases with increasing energy, but gamma rays originating inside the casing are not attenuated.) This effect is observed on May 3, 2004, logging run 3 (135 to 71 ft), and the repeat log run (70 to 46 ft). The effects of radon appear to be minimal in the other log runs. The reason for variations in radon content between log runs on successive days is not known. Variations in radon content in boreholes are probably related to variations in surface weather conditions. Radon daughters such as ^{214}Bi may also "plate" onto the sonde itself. When this occurs, there is a gradual increase in total counts as well as photopeak counts associated with ^{214}Bi and ^{214}Pb.

The presence of radon is not an indication of man-made contamination; it is derived from decay of naturally occurring uranium. As a gas, radon moves easily in the subsurface, and concentrations of radon and its associated progeny can change quickly.

The plots of the repeat logs demonstrate reasonable repeatability of the SGLS data for the natural radionuclides at energy levels of 609, 1461, 1764, and 2614 keV and man-made radionuclides (^{137}Cs, ^{238}U, and ^{60}Co). The repeat log run at 609 keV is slightly elevated compared to the original log due to the build of radon in the borehole.

Gross gamma logs from Fecht et al. (1977) (attached) indicate that the sediments surrounding this borehole contained significant amounts of man-made gamma radiation from 1958 through at least 1976. The logs from 1958 and 1963 indicate that contamination reached groundwater. The logs from 2/27/58 and 5/9/63 appear to detect relatively high gamma activity in the interval from 20 ft (6 m) to the bottom of the borehole (100 m). The log from 5/14/76 appears to detect relatively high gamma activity in the interval from 26 ft (8 m) to 154 ft (47 m) and slightly elevated gamma activity in the interval from 207 ft (63 m) to 233 ft (71 m). Comparison of these gross gamma logs indicates that a major contamination event occurred prior to 1958. The SGLS detected ^{137}Cs and ^{60}Co in the intervals that had elevated gamma in 1976. Man-made ^{238}U was detected only in the upper portion of the borehole (46 and 47 ft) with the SGLS.

References:

Fecht, K.R., G.V. Last, and K.R. Price, 1977. *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells*, ARH-ST-156, Atlantic Richfield Hanford Company, Richland, Washington.

Ledgerwood, R.K., 1993. *Summaries of Well Construction Data and Field Observations for Existing 200-West Resource Protection Wells*, WHC-SD-ER-TI-005, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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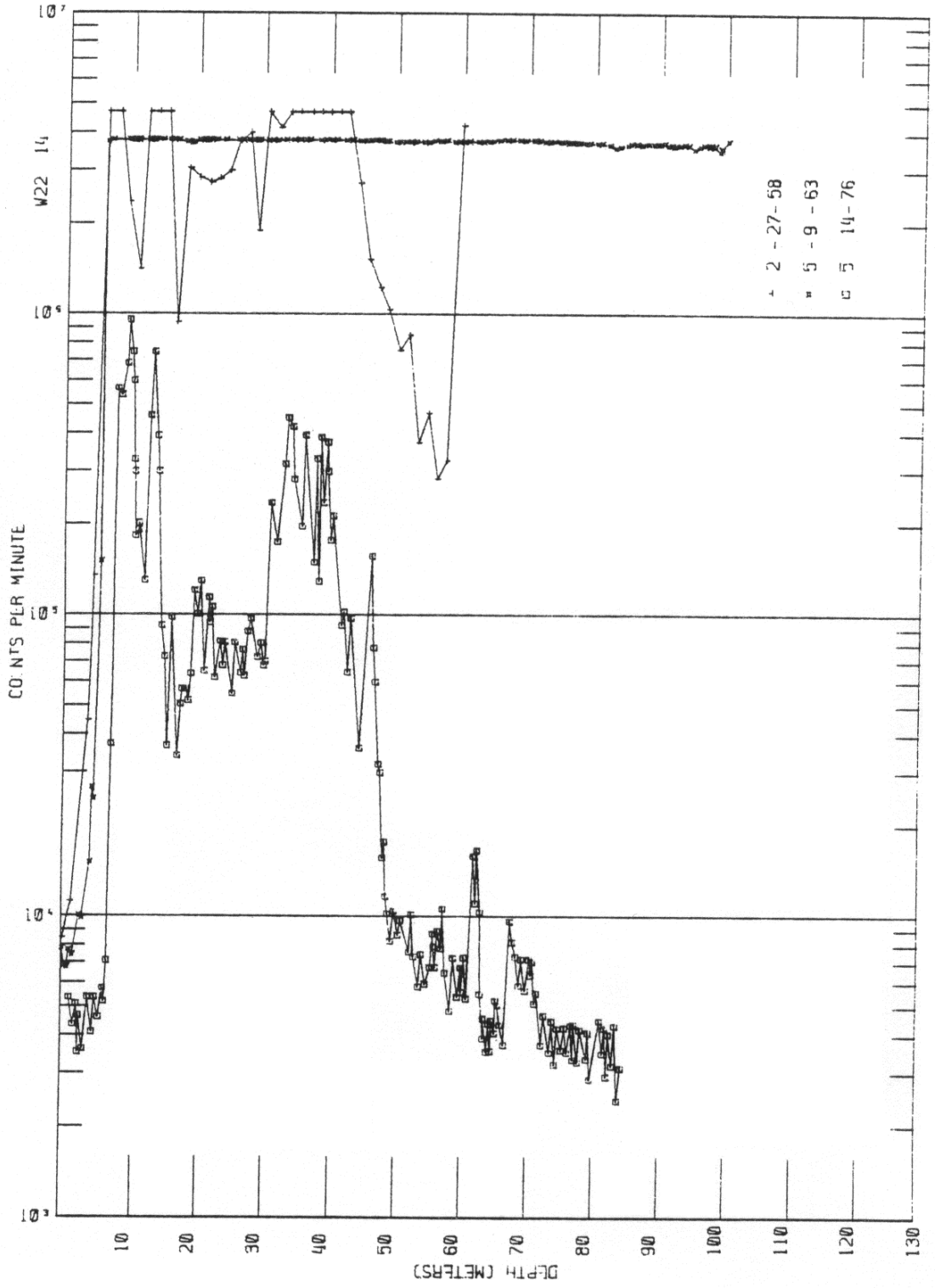
[1] GWL – groundwater level
[2] TOC – top of casing
[3] HWIS – Hanford Well Information System
[4] N/A – not applicable

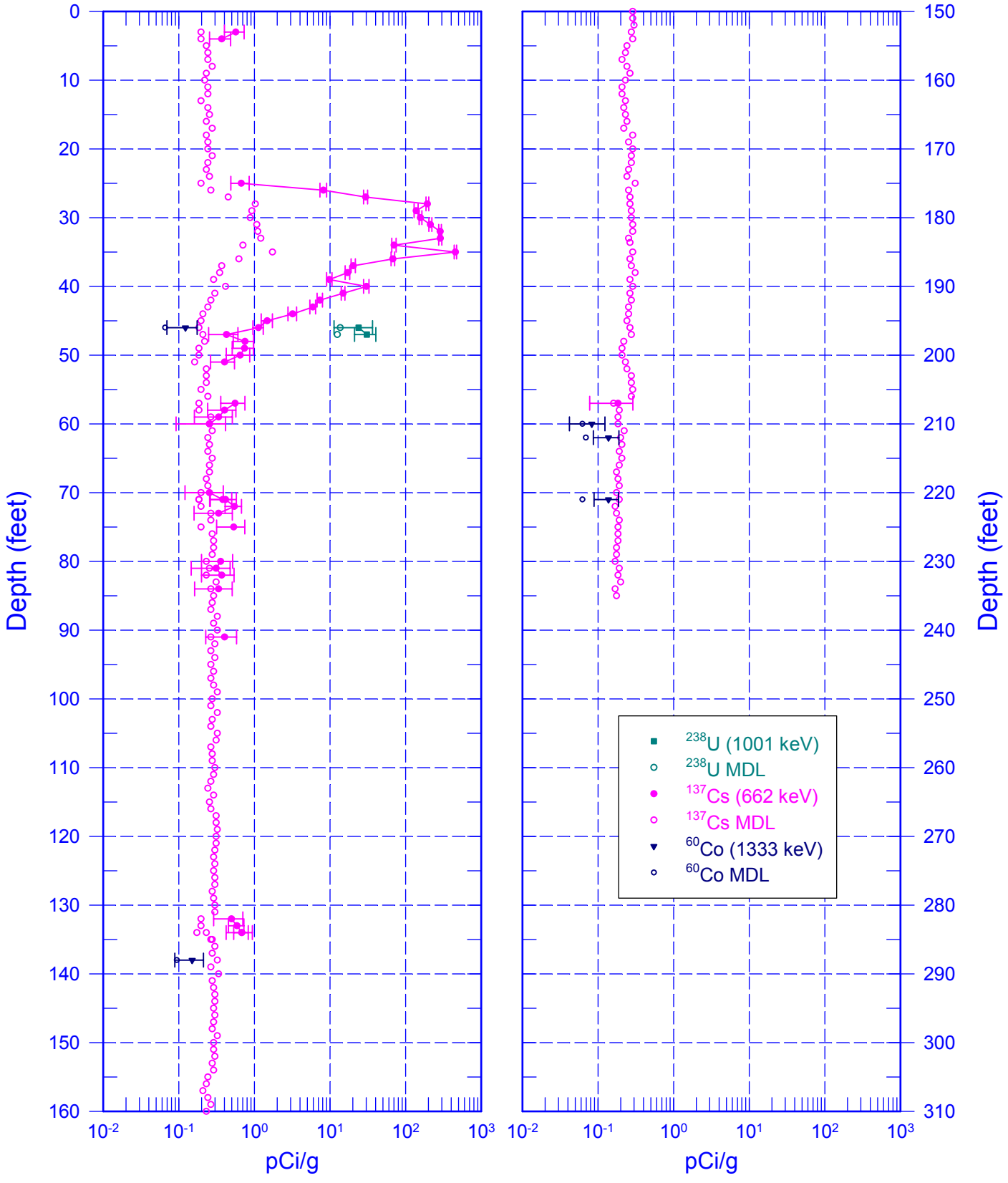


from Fecht et al. (1977)

Scintillation Probe Profiles for Borehole 299-W22-14, Logged on 2/27/58, 5/9/63, and 5/14/76

299-W22-14 (A7839)

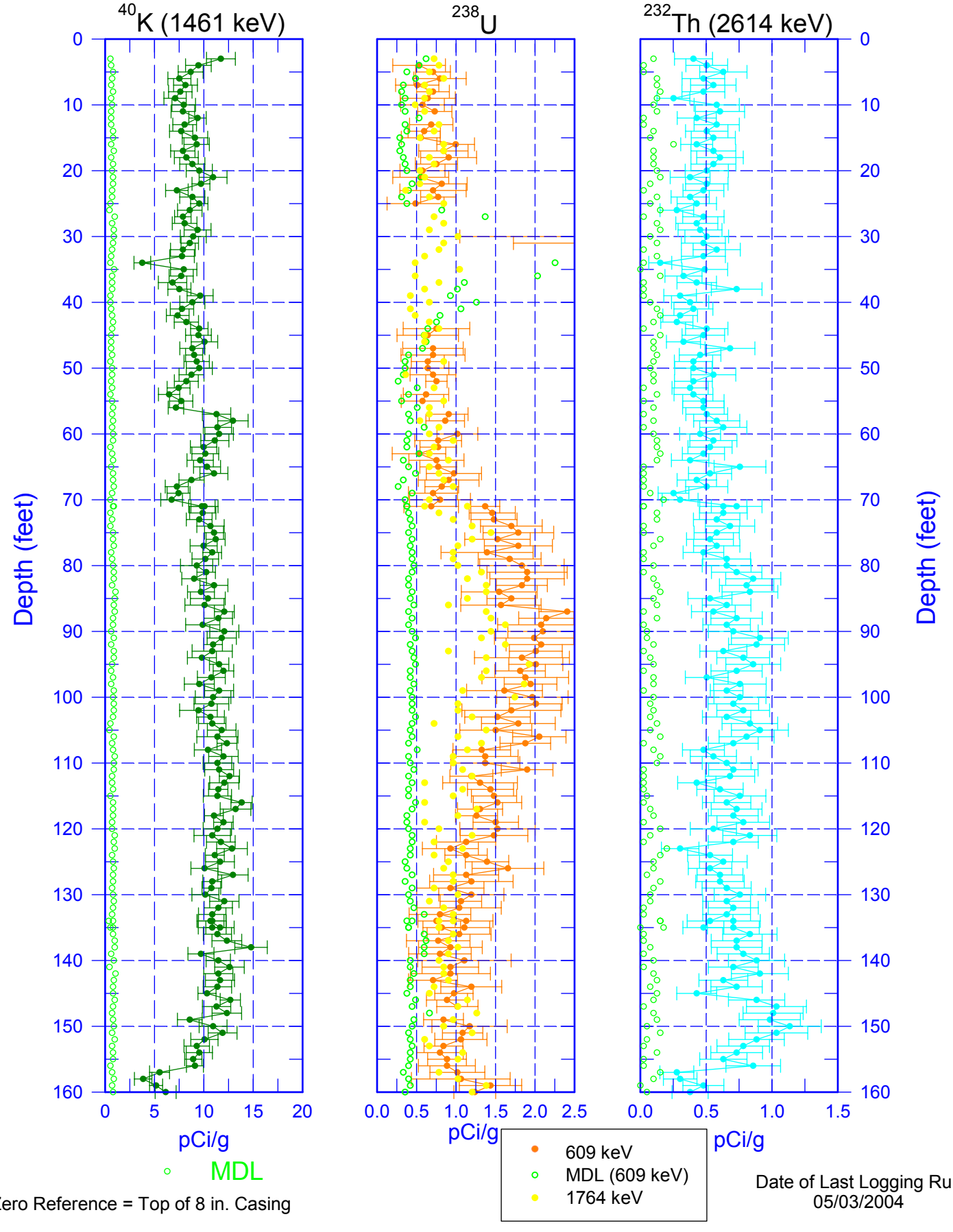
Man-Made Radionuclides



Zero Reference = Top of 8 in. Casing

Date of Last Logging Run
5/03/2004

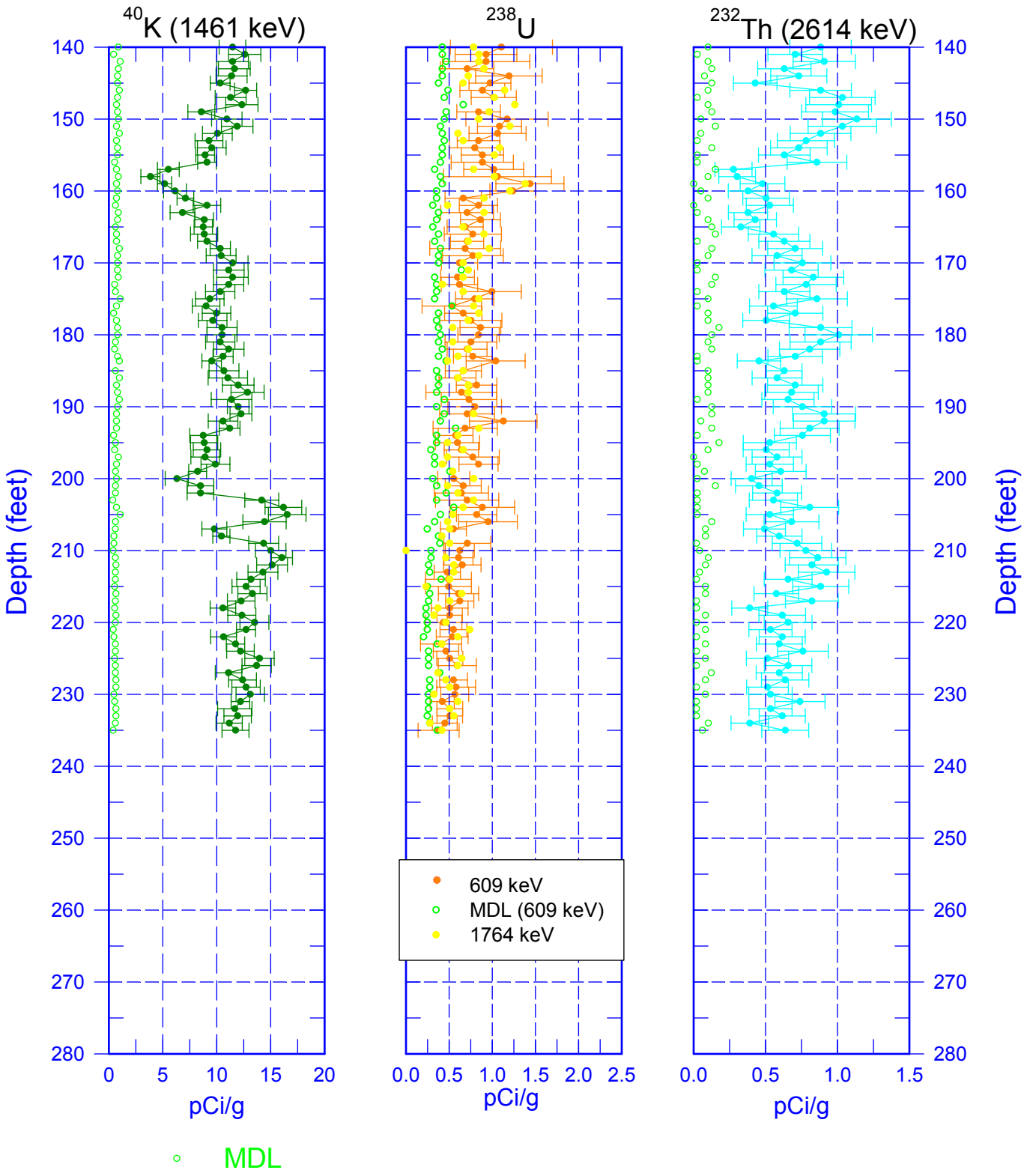
299-W22-14 (A7839)
Natural Gamma Logs



Zero Reference = Top of 8 in. Casing

Date of Last Logging Run
05/03/2004

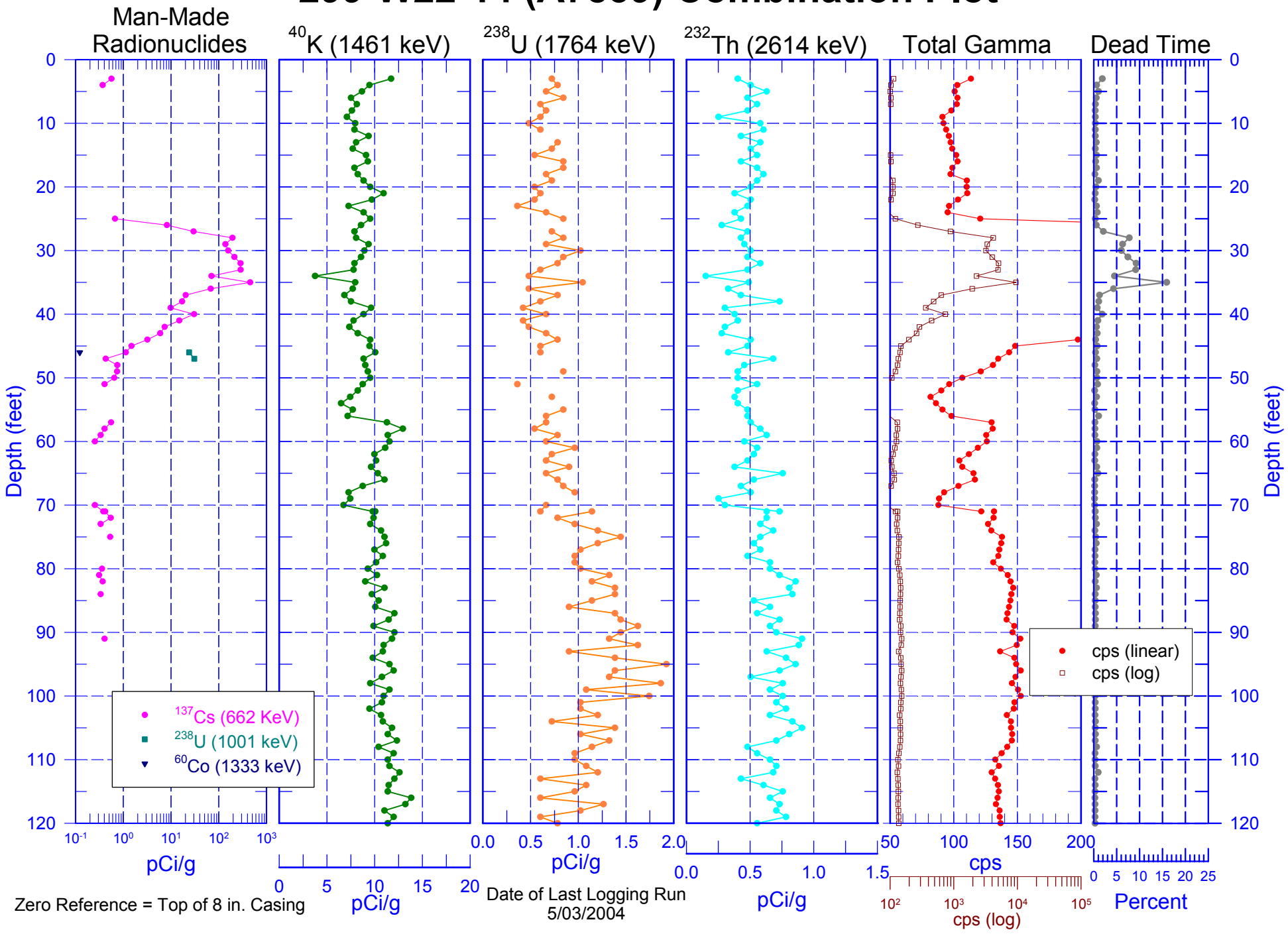
299-W22-14 (A7839)
Natural Gamma Logs



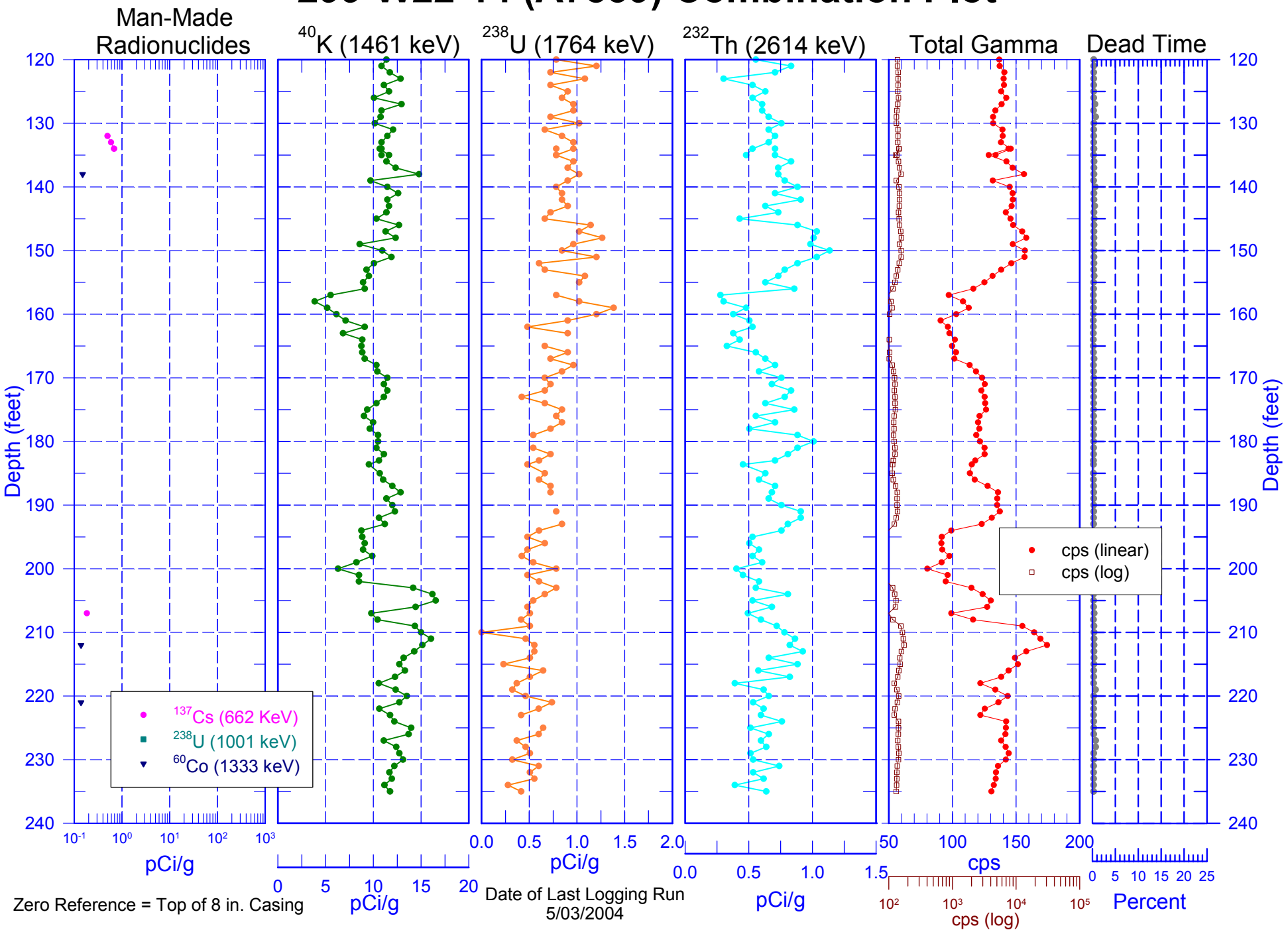
Zero Reference = Top of Casing

Date of Last Logging Run
5/03/2004

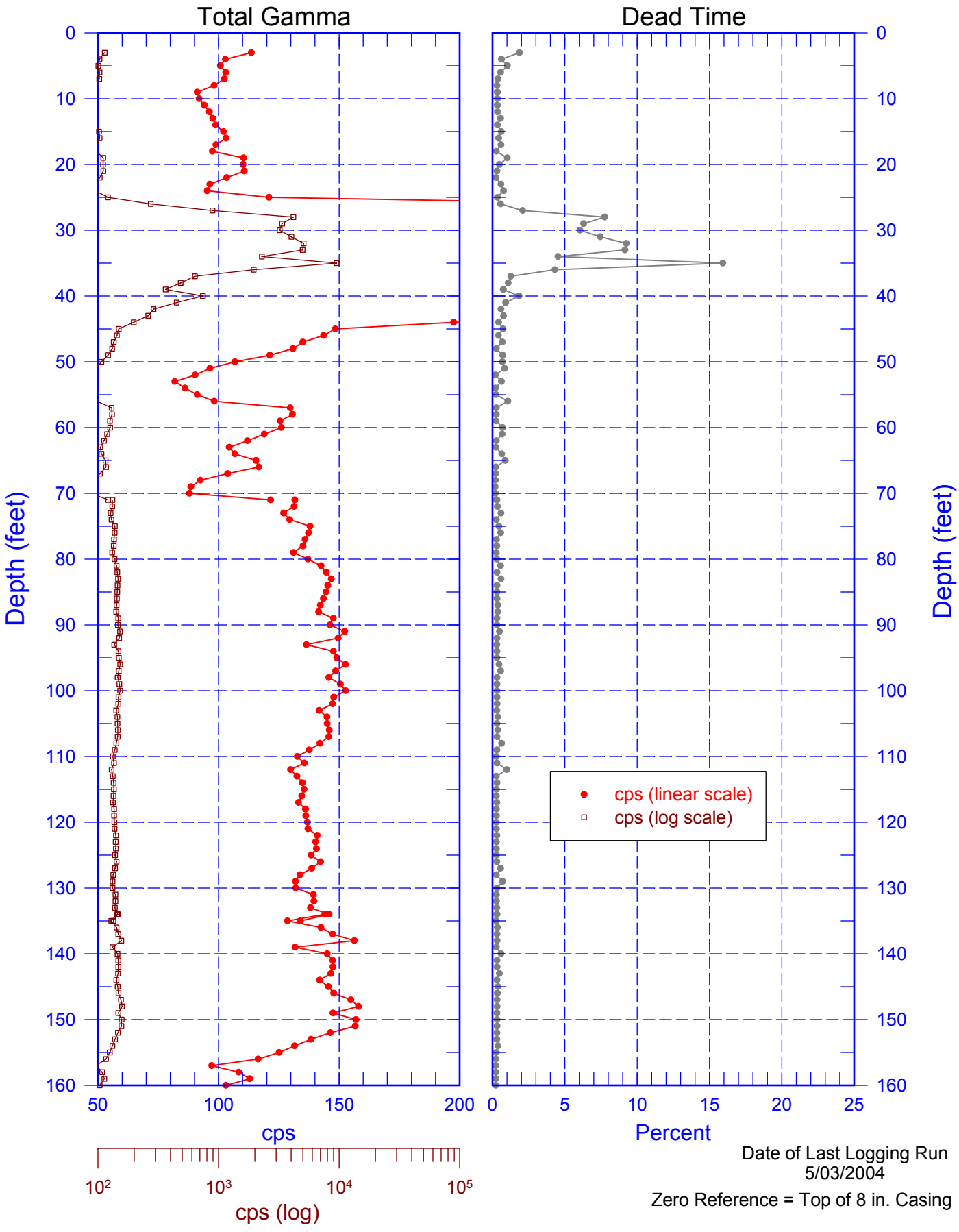
299-W22-14 (A7839) Combination Plot



299-W22-14 (A7839) Combination Plot



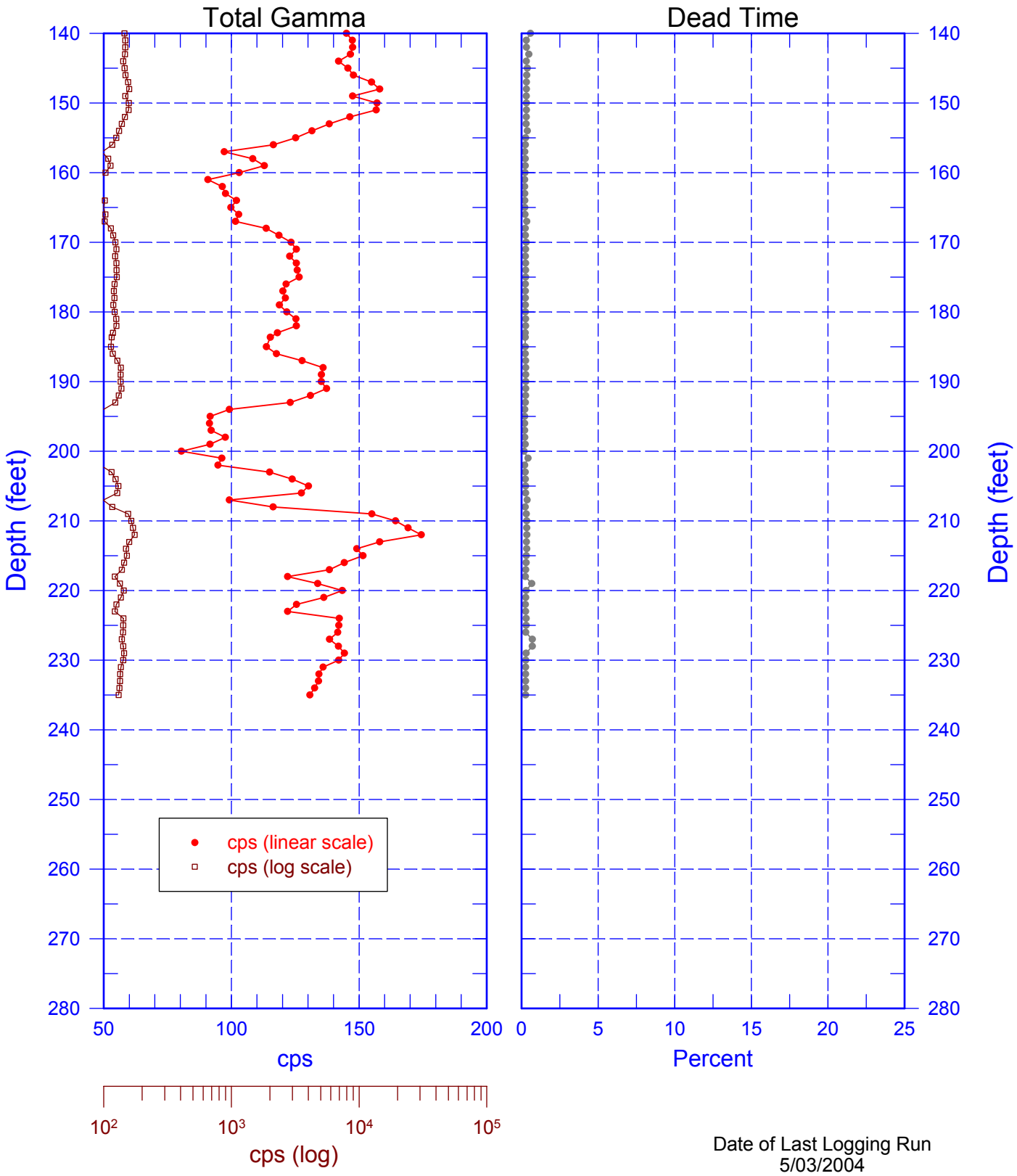
299-W22-14 (A7839)
Total Gamma & Dead Time



Date of Last Logging Run
5/03/2004

Zero Reference = Top of 8 in. Casing

299-W22-14 (A7839)
Total Gamma & Dead Time

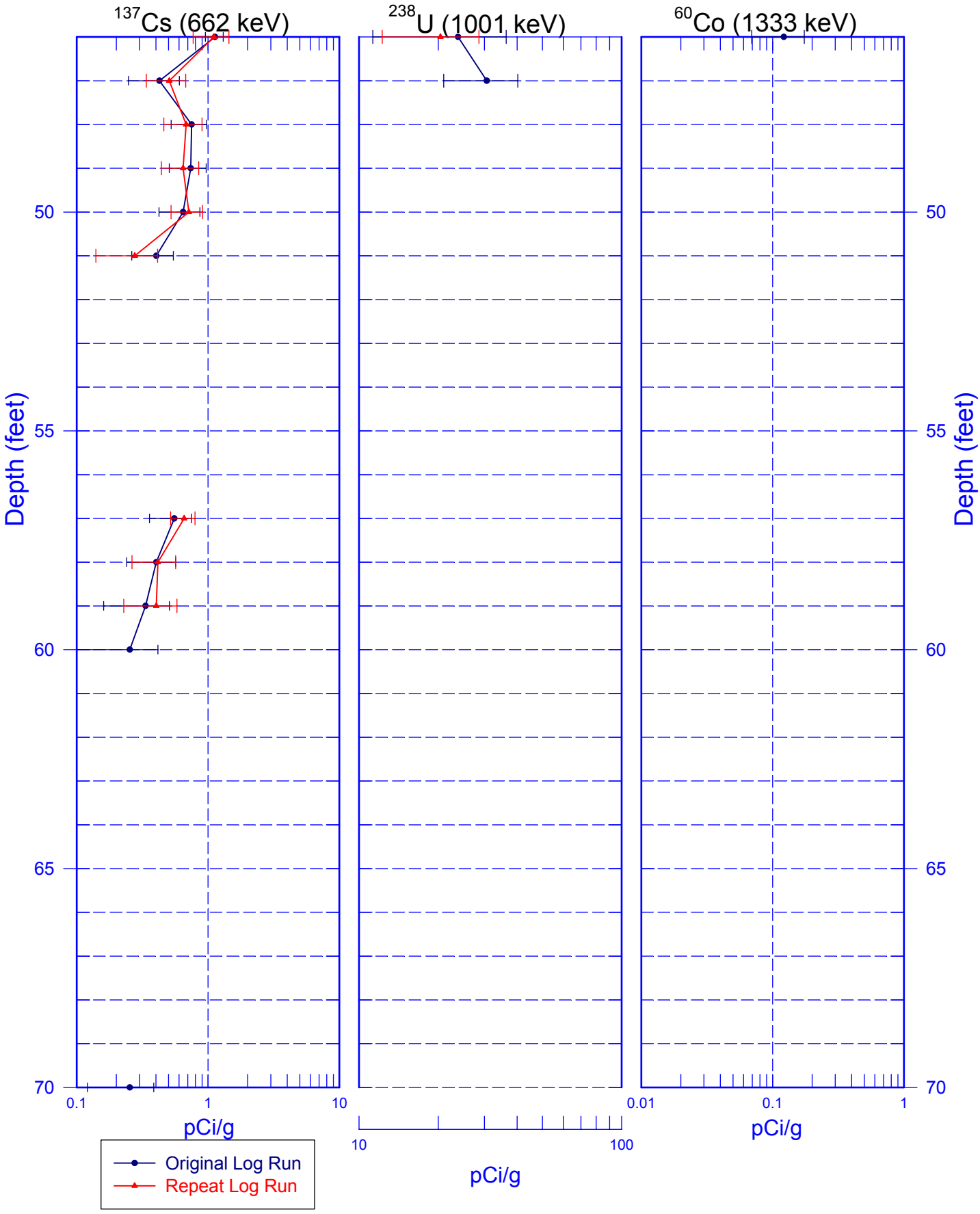


Date of Last Logging Run
5/03/2004

Zero Reference = Top of Casing

299-W22-14 (A7839)

Rerun of Man-Made Radionuclides (70.0 to 46.0 ft)



299-W22-14 (A7839)

Rerun of Natural Gamma Logs (70.0 to 46.0 ft)